FISHERY RESEARCH

DWORSHAK RESERVOIR KOKANEE POPULATION MONITORING

ANNUAL PROGRESS REPORT
January 1, 1999 – December 31, 1999

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Project Progress Report

1999 Annual Report

By

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To

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, OR 97283-3621

Project Numbers 198709900
Contract Numbers 1987BI35167

IDFG Report Number 01-37
August 2001

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

We used split-beam hydroacoustics and trawling to monitor the kokanee *Oncorhynchus nerka* population in Dworshak Reservoir during 1999. Estimated abundance of kokanee has continued to increase since the high entrainment losses in the spring of 1996. Based on hydroacoustic surveys, we estimated 1,545,000 kokanee and rainbow trout *O. mykiss* in Dworshak Reservoir during July 1999. This included 1,144,000 age-0 kokanee (90% CI +/- 42%), 212,000 age-1 kokanee (90% CI +/- 15%), and 189,000 age-2 kokanee and stocked rainbow trout (90% CI +/- 39%). Rainbow trout could not be distinguished from the age-2 kokanee in the echograms since they were of similar size. Age-0 kokanee ranged in length from 40 mm to 90 mm, age-1 from 193 mm to 212 mm, and age-2 kokanee from 219 mm to 336 mm. These sizes indicated kokanee are still growing well. Discharge of water from Dworshak Dam during 1999 did not stop the expansion of the kokanee population based on these results. Counts of spawning kokanee in four tributary streams exceeded 11,000 fish. This index also showed a marked increase from last year's 660 spawning kokanee or the 1997 total of 144 spawning kokanee.

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INTRODUCTION

Kokanee *Oncorhynchus nerka* in Dworshak Reservoir provide a very popular fishery and have had harvests of over 200,000 fish (Mauser 1989). The fishery, however, is highly variable. Adult kokanee densities within the reservoir can vary more than 20 fold. These variations in fish abundance correlated with high flows through Dworshak Dam. The wetter years corresponded to poorer survival between kokanee year classes (Maiolie and Elam 1993). This was attributed to the entrainment losses of kokanee into the dam. We estimated that 1.4 million kokanee (95% of the population) were lost through the dam in a period of five months during 1996 (Maiolie and Elam 1998).

In this study we used mobile split-beam hydroacoustics to quantify abundance of kokanee and midwater trawling to obtain representative samples of fish for identification and aging. This monitoring was done to determine the response of the kokanee population to the operation of the dam during the previous year.

OBJECTIVE

To maintain densities of 30 to 50 harvestable-sized kokanee/ha in Dworshak Reservoir by reducing entrainment losses.

DESCRIPTION OF STUDY AREA

Dworshak Dam is located on the North Fork of the Clearwater River in northern Idaho. At 219 m high, it is the largest straight-axis concrete dam in the United States. It was built in 1971 for power production and flood control. Three turbines within the dam have a total operating capacity of 450 megawatts. The dam can discharge up to 380 m^3/s (10,000 cfs) through the turbines and an additional 420 m^3/s (15,000 cfs) through reservoir outlets and the spillway.

The reservoir behind the dam is 86 km long at full pool (Figure 1). Maximum and mean depths are 194 m and 56 m, respectively. Surface area at full pool is 6,644 ha with 5,400 ha of kokanee habitat (defined as the area over 15 m deep). Drawdowns for flood control may lower the surface elevation 47 m and reduce surface area by as much as 52%. The reservoir has a mean retention time of 10.2 months and a mean annual discharge of 162 m^3/s (Falter 1982). High releases from the reservoir occur during spring run-off, during late summer when water is released for anadromous fish flows, and during the fall when the reservoir is lowered for flood control.

Kokanee were first stocked into Dworshak Reservoir in 1972 (Horton 1981). Four sources of fish were initially used, but the early spawning strain from Anderson Ranch Reservoir, Idaho now populates the reservoir (Winans et al. 1996). These fish spawn during September in tributary streams as far as 140 km above the reservoir. They reach maturity primarily at age-2, although age-1 and age-3 spawners were occasionally found. Adults range

in size from 200 to 400 mm in total length depending on their density in the reservoir, but generally average 300 mm during spawning (Maiolie and Elam 1995).
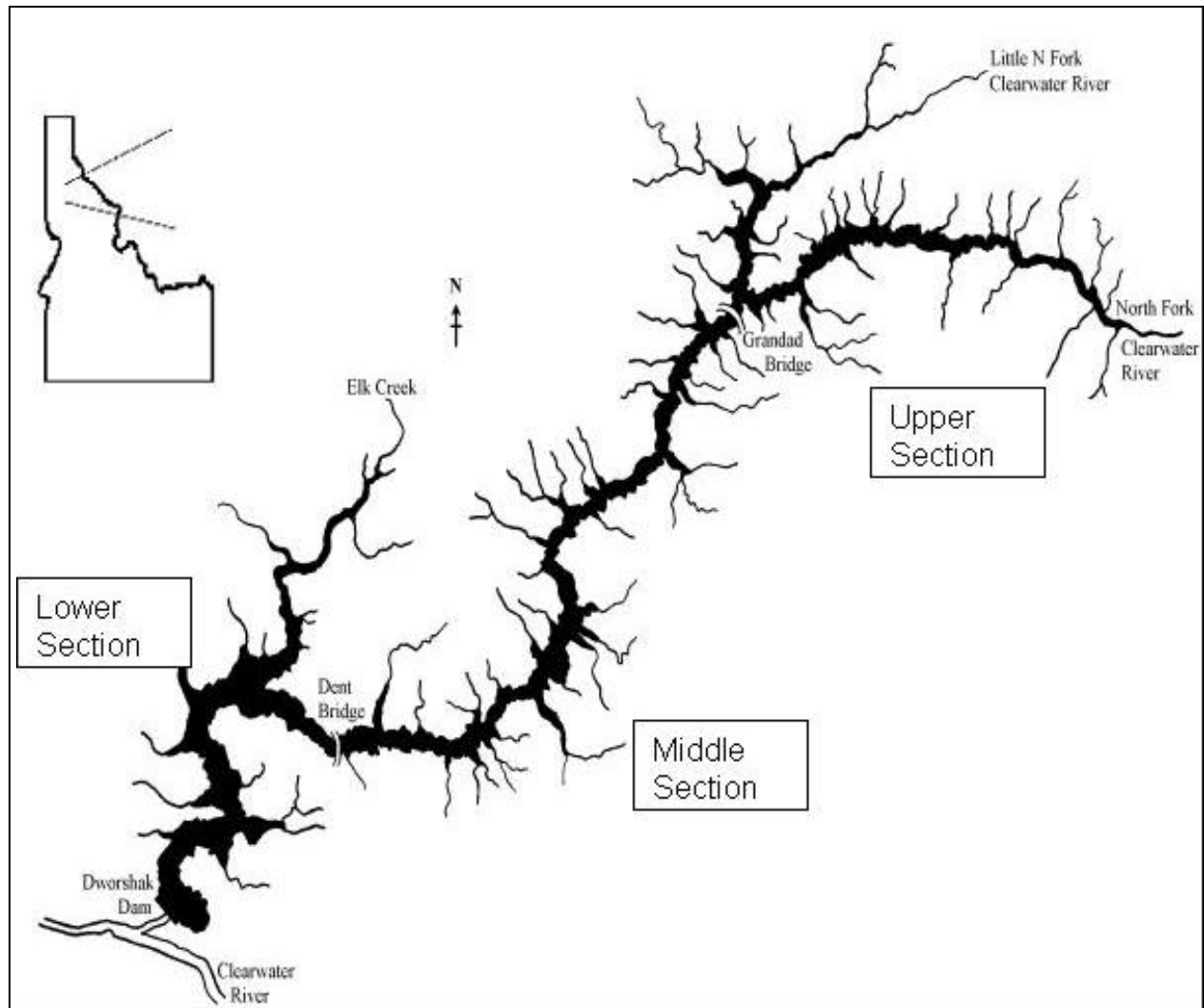
Figure 1.   Map of Dworshak Reservoir, its major tributaries, and three sampling sections, North Fork Clearwater River, Idaho. The two bridges served as section boundaries.

METHODS

Hydroacoustics

We used a Simrad EY500 split-beam scientific echosounder with a 120 kHz transducer to document the abundance and distribution of kokanee. Boat speed was 1.5 to 2.3 m/s and all surveys were conducted at night. The echosounder was set to ping at 0.7 s intervals, with a pulse width of 0.3 milliseconds. Data were collected with a time varied gain constant of 20 log r (range). We calibrated the echosounder at the beginning of the year using a 23 mm copper

calibration sphere with a target strength of -40.4 dB (decibels). We checked the calibration of the echosounder prior to each nightly survey and adjusted the transducer gains if needed.

We configured the echosounder so that only echoes meeting certain criteria would be regarded as a fish. First, the returned echo had to be greater than -60 dB. The length of the returned echo had to be between 0.8 and 1.8 times the length of the echosounder's ping. The echo could not require more than 4.0 dB compensation for being off the acoustic axis, and the target had to be within a 7.1° cone. Echoes meeting these criteria were classified as a fish "trace" (a single returned echo from a single fish).

Fish density estimates were calculated using EP-500 software, version 5.2. Densities were based on echo integration techniques to account for fish within schools that could not be distinguished as single targets. We analyzed only the pelagic region of each echogram, generally from depths of 5 m to 50 m. Previous midwater trawling in Dworshak Reservoir showed that the pelagic layer of fish at these depths was nearly all kokanee (Idaho Fish and Game files). Trawling was also conducted in 1999 to verify the species assemblage in the pelagic fish community.

We graphed a frequency distribution of the fish's target strengths to separate kokanee into age classes. The frequency distribution was used to define three peaks that corresponded to the three age classes of kokanee.

Reservoir-wide hydroacoustic surveys were conducted to estimate kokanee abundance. We used a systematic, stratified survey design (Scheaffer et al. 1990). The reservoir was stratified into three sections (Figure 1): the dam to Dent Bridge (section 1), Dent Bridge to Granddad Bridge (section 2), and Granddad Bridge to the headwaters (section 3). Mean fish densities in each reservoir section were multiplied by the area of that section then totaled to obtain population estimates. Ninety percent confidence limits were placed on the total kokanee population estimates using a formula for stratified systematic designs (Scheaffer et al. 1990).

Survey transects were spaced at 3.2 km intervals throughout the length of the reservoir using Global Positioning System (GPS) locations. Surveys were conducted on the evenings of July 26 and 27, 1999.

Discharge

Data on monthly discharge from the dam were obtained from the U.S. Army Corps of Engineers. Time and magnitude of discharge from Dworshak Dam is used to examine correlations between potential entrainment and population abundances.

Trawling

Oblique tows of a midwater trawl net were used to collect representative samples of fish for aging. An 8.8 m boat with a 300 hp diesel engine towed the trawl net, which was 13.7 m long with a 9.29 m^2 mouth. Mesh sizes (stretch measure) graduated from 32 mm to 25 mm to 19 mm to 13 mm in the body of the net and terminated in a 6 mm mesh cod end.

All trawling was conducted after dark during the new moon phase to optimize capture efficiency (Bowler et al. 1979). Net towing speed was 1.5 m/s. Depth of the kokanee in the

reservoir was determined using a Furuno Model FCU582 depth sounder with a 10-degree transducer. The vertical distribution of kokanee was divided into 3.5 m sublayers; usually three to five sublayers encompassed the vertical distribution. A stepwise oblique net tow was made through the kokanee layer. The net was pulled for 3 min in each sublayer, sampling 2,508 m^3 of water over a distance of 270 m (at a boat speed of 1.5 m/s). The time it took to readjust the net between sublayers and the time the net was in the kokanee layer while initially setting the net was also entered into density estimates (approximately 34 s between each sublayer while raising and lowering the net).

A stratified random sampling design was used to select trawl locations. The reservoir was divided into three sections with Dent Bridge and Granddad Bridge serving as boundary lines (Figure 1). Section 1 was the lower end of the reservoir (2,959 ha of kokanee habitat); section 2 the middle (1,796 ha of kokanee habitat), and section 3 was the upper reservoir (641 ha of kokanee habitat). Three transects were made in section 1 at rkm 3.2, 11.3, and 19.3. Four transects were made in section 2 at rkm 32.2, 37.0, 45.1, and 54.7. Two transects were made in section 3 at rkm 72.4 and 74.0. Trawl direction was parallel to the long axis of the reservoir due to spatial limitations. A detailed description of trawling methodology was presented in Rieman (1992). Trawling was conducted on the nights of July 12 and 13, 1999.

Scales from fish collected in the trawls were used to verify lengths of kokanee within each age class. Scales were collected above the lateral line and posterior to the dorsal fin using techniques described by Nielsen and Johnson (1985). Scales were loosened by scraping toward the head with a blunt knife. Ten or more scales were collected from each fish and sealed in a coin envelope labeled with total length and date collected. Scales were prepared by pressing four to six individual scales between two acetate slides. The resulting scale impressions were viewed using a microfiche reader. Areas of relatively slower growth signifying each winter season or the end of one year's growth (annuli) were counted to determine age. Aging techniques were described by Nielsen and Johnson (1985).

Spawner Counts

We counted kokanee in four tributaries to Dworshak Reservoir to serve as an additional relative index of the adult population. Spawning kokanee were counted in Isabella Creek, Dog Creek, Skull Creek, and Quartz Creek. We walked these streams from their mouths to the furthest upstream reaches utilized by kokanee. These tributaries were surveyed annually from 1981 to 1999 on or near September 25, which is generally the peak of kokanee spawning (Horton 1980).

RESULTS

Hydroacoustics

We estimated 1,545,000 kokanee and rainbow trout in Dworshak Reservoir in July of 1999 based on hydroacoustics. This included 1,144,000 age-0 kokanee (90% CI +/- 42%), 212,000 age-1 kokanee (90% CI +/- 15%), and 189,000 age-2 kokanee and stocked rainbow trout (90% CI +/- 20%). Stocked rainbow trout could not be separated from the age-2 kokanee in the echograms since they were of similar size. Estimates of age-0 and age-1 kokanee were not thought to include rainbow trout since stocked trout were of catchable size. Total density of

fish in section 1 was 152 fish/ha. Densities in section two and three were 340 fish/ha and 759 fish/ha, respectively. Abundance of age-0 kokanee was highest in section 2 (465,000) and lowest in section 1 (258,000). Abundance of age-1 kokanee was highest in section 1 (93,000) and lowest in section 3 (38,000). Abundance of age-2 kokanee (including stocked rainbow trout) was highest in section 1 (98,000) and lowest in section 3 (27,000) (Figure 2).
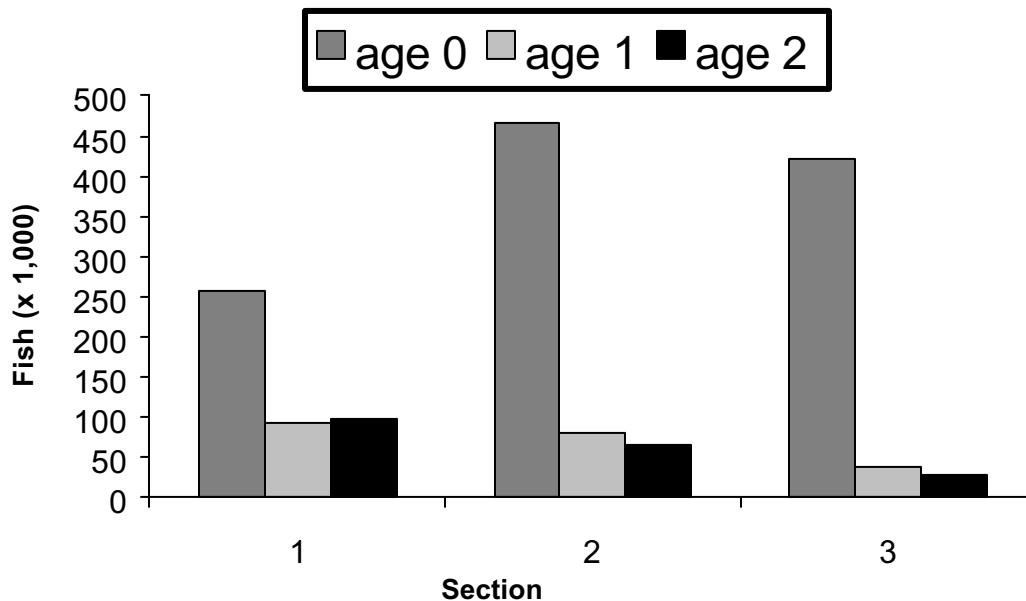

Figure 2. Abundance estimates for age-0, age-1, and age-2 kokanee (and stocked rainbow trout) based on hydroacoustic sampling in Dworshak Reservoir, 1999.

Based on the results of the hydroacoustic surveys and the trawl catch, we defined age-0 kokanee as fish between -60 and -42 dB, estimated between 25 and 145 mm (Love 1971) (Figure 3). Age-1 kokanee were defined as fish between -42 and -38 dB (145 mm – 230 mm). Age-2 kokanee and rainbow trout were defined as fish over -38 dB (230 mm and larger).

Discharge

Mean daily flows from Dworshak Dam varied from a low of 39.6 m^3/s in June to a high of 464.3 m^3/s during August 1999 (Figure 4). High flows also occurred during spring runoff, with flows reaching 393.5 m^3/s in March; however, the highest releases of the year came in August to aid anadromous fishes downstream. Water was spilled at different times during March, April, May, July, and August. In 1999 the greatest frequency and magnitude of spill was in March. Discharge of water from Dworshak Dam during 1999 did not seem to adversely affect kokanee abundance based on results from hydroacoustic surveys.
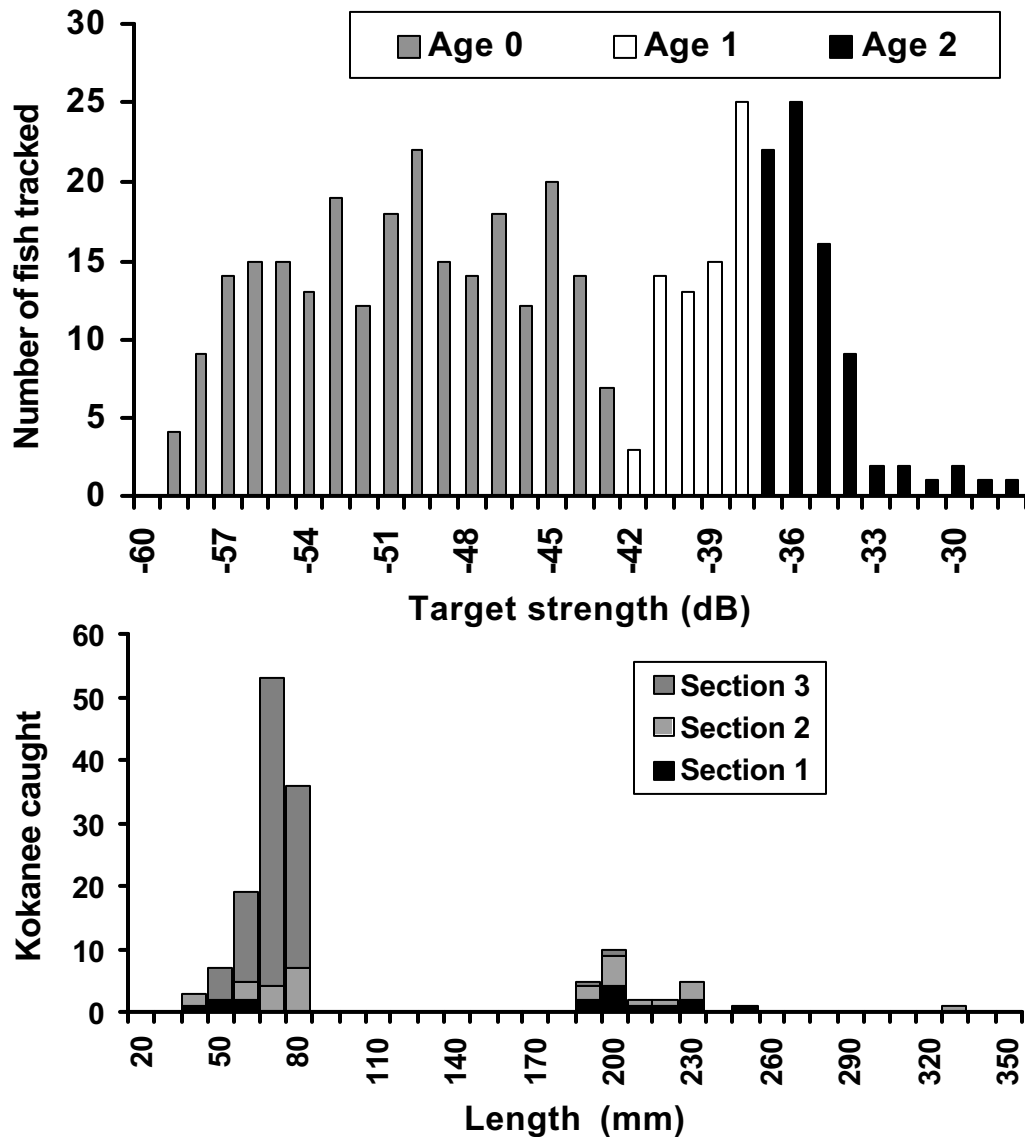
Figure 3. Frequency distributions of fish tracked by hydroacoustics (top) and lengths of all kokanee caught by midwater trawling (bottom) in Dworshak Reservoir, 1999.

Trawling

Of the 141 fish caught in the trawl, 118 were age-0 kokanee, 13 were age-1 kokanee, eight were age-2 kokanee, and one was a rainbow trout. Age-0 kokanee ranged in length from 40 mm to 90 mm, age-1 kokanee ranged from 193 mm to 212 mm, age-2 kokanee ranged from 219 mm to 336 mm, and the single rainbow trout was 259 mm in length (Figure 3).

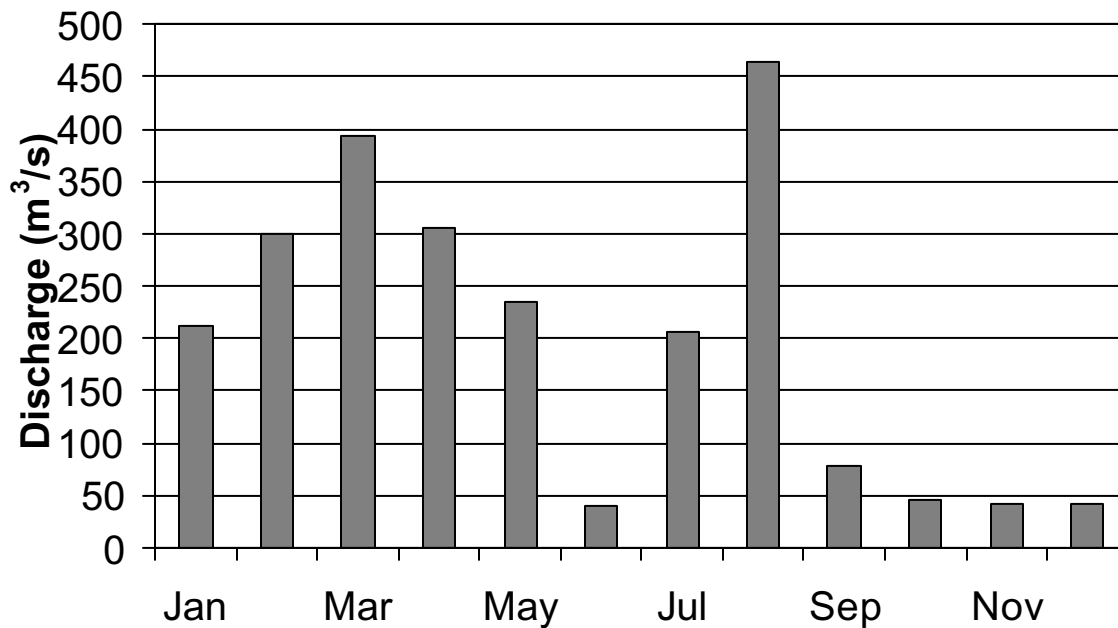Figure 4.   Mean daily discharge from Dworshak Dam during 1999.

Spawner Counts

There was a 17-fold increase in the number of kokanee counted in spawning tributaries surveyed from 1998 (660) to 1999 (11,320). This year's count was the highest since 1995 (Table 1). Increases in counts of spawning kokanee are consistent with increases based on hydroacoustic and trawl estimates.

DISCUSSION

Increased abundance estimates in 1999 indicated that kokanee might be recovering from the 95% entrainment losses in 1996 (Maiolie et al. 1999). Densities of age-0, age-1, and age-2 kokanee increased substantially from previous years (Table 2), as did the number of kokanee spawning in tributaries (Table 1). Hatchery supplementation in 1998 (480,000 kokanee fry) and 1999 (890,000 kokanee fry) likely contributed to the increased numbers of fish in recent years. Although growth comparisons are not available for previous years, kokanee growth in 1999 was very good. Age-0 kokanee were 40 mm to 90 mm, age-1 kokanee ranged from 193 mm to 212 mm, and age-2 kokanee were >219 mm. Growth of this magnitude allows age-1 fish to recruit to the fishery and increase catch rates. The fishery in 2000 is expected to be good based on the 212,000 age-1 kokanee estimate.

8

Table 1. Number of kokanee spawners counted in selected tributaries to Dworshak Reservoir during September 1981-1999

Year	Isabella Creek	Skull Creek	Quartz Creek	Dog Creek	Total (Isabella, Quartz, and Skull)[a]
1999	10,132	361	827	2,207	11,320
1998	627	20	13	18	660
1997	144	0	0	0	144
1996	2,552	4	13	82	2,569
1995	12,850	20,850	2,780	1,160	36,480
1994	14,613	12,310	4,501	1,878	31,424
1993	29,171	7,574	2,476	6,780	39,221
1992	7,085	4,299	1,808	1,120	13,192
1991	4,053	1,249	693	590	5,996
1990	10,535	3,219	1,702	1,875	15,456
1989	11,830	5,185	2,970	1,720	19,985
1988	10,960	5,780	5,080	1,720	21,820
1987	3,520	1,351	1,477	700	6,348
1986	—	—	—	—	—
1985	10,000	8,000	2,000		20,000
1984	9,000	2,200	1,000		12,200
1983	2,250	135	66		2,451
1982	5,000	4,500	1,076		10,576
1981	4,000	3,220	850		8,070

[a] Total does not include Dog Creek because it was not counted until 1987.

Between March 1 and June 30, 1999, over 150,000 catchable-sized (245 mm to 255 mm) rainbow trout were stocked into the reservoir. These were a domestic Kamloops strain that may have utilized the pelagic zone of the reservoir. Based on past trawling efforts, we found that most pelagic fish in Dworshak Reservoir were kokanee. This year, of the fish over 219 mm, one fish out of nine was a rainbow trout. We caution that kokanee and rainbow trout cannot be differentiated by hydroacoustics. This is especially true in 1999, as there was considerable overlap in the sizes of the two species and a substantial number of rainbow trout were stocked. The estimate of fish over -37 dB (the age-2 kokanee and catchable-size rainbow trout) in 1999 (189,000 fish) likely contained a large number of rainbow trout since this year class was estimated at only 73,000 fish the previous year (Table 2). Even with 90% survival for the previous years age-1 kokanee, 123,000 of the 189,000 fish over -37 dB would be rainbow trout.

Discharge from Dworshak Dam was low during the fall and early winter of 1999 (Figure 4). If low flows continue into the spring of 2000, over-winter survival of kokanee should be good and allow for a further improvement in the kokanee population.

Table 2.   Estimated abundance of kokanee (thousands) in Dworshak Reservoir, Idaho, 1988-1999.

Month and year	Sampling Technique	Age Classes 0	1	2	3	Total	Density Age-2 and -3 (fish/ha)
July 1999	Hydroacoustics	1,144	212	189[c]	0	1,545	35[c]
July 1998	Hydroacoustics	537	73	39	0	649	7
July 1997	Trawling	65	0	0	0	65	0
July 1996	Hydroacoustics	231	43	29	0	303	5
June 1995[a]	Hydroacoustics	1,635	1,309	595	0	3,539	110
July 1994	Trawling	156	984	309	9	1,458	69
July 1993	Trawling	453	556	148	6	1,163	33
July 1992	Trawling	1,043	254	98	0	1,395	22
July 1991	Trawling	132	208	19	6	365	5
Sept. 1990[b]	Trawling	978	161	11	3	1,153	3
June 1989[a]	Trawling	148	148	175	0	471	32
July 1988	Trawling	553	501	144	12	1,210	29

[a]   June sampling likely resulted in underestimation of age-0 kokanee.
[b]   September trawling likely resulted in underestimation of the mature fish.
[c]   Age-2 kokanee were likely overestimated due to the stocking of 150,000 catchable-sized rainbow trout in 1999.

CONCLUSIONS

Based on population abundance estimates derived using hydroacoustic techniques and spawner counts, kokanee numbers (with the aid of hatchery supplementation in 1998 and 1999) appeared to be recovering from heavy entrainment losses suffered in 1996. Favorable conditions, apparently minimal entrainment losses, and low abundances of kokanee in recent years have allowed good growth and survival of kokanee in Dworshak Reservoir.

RECOMMENDATIONS

1. Continue to examine ways to reduce future entrainment losses.

2. Check anglers at the time of the hydroacoustic surveys to determine the size of age-1 and age-2 kokanee. This would prove helpful in splitting age-1 and -2 kokanee on the echograms and could provide larger sample sizes than trawling.

ACKNOWLEDGMENTS

LITERATURE CITED

Bowler, B., B. E. Rieman, and V. L. Ellis. 1979. Pend Oreille Lake fisheries investigations. Idaho Department of Fish and Game, Job Performance Report, Project No. F-73-R-1, Boise, Idaho.

Falter, C. M. 1982. Limnology of Dworshak Reservoir in a low flow year. U.S. Army Corps of Engineers. Walla Walla, Washington.

Horton, W. A. 1980. Dworshak Reservoir fisheries investigations. Idaho Department of Fish and Game. Job Performance Report, Prepared for United States Army Corps of Engineers, Contract Number DACW68-79-C-0034, Boise, Idaho

Horton, W. A. 1981. Dworshak Reservoir fisheries investigations. Idaho Department of Fish and Game. Job Performance Report, Prepared for United States Army Corps of Engineers, Contract Number DACW68-79-C-0034, Boise, Idaho.

Love, R. H. 1971. Dorsal-aspect target strength of an individual fish. Journal of the Acoustic Society of America, 49:816-823.

Maiolie, M. A. and S. Elam. 1993. Dworshak Dam impacts assessment and fisheries investigation. Idaho Department of Fish and Game, Annual Progress Report, Prepared for U.S. Department of Energy, Bonneville Power Administration, Project No. 87-99, Portland, Oregon.

Maiolie, M. A. and S. Elam. 1995. Dworshak Dam impacts assessment and fisheries investigations project. Idaho Department of Fish and Game, Annual Progress Report, Prepared for U.S. Department of Energy, Bonneville Power Administration, Project No. 89-99, Portland, Oregon.

Maiolie, M. A. and S. Elam. 1998. Kokanee entrainment losses at Dworshak Reservoir. Idaho Department of Fish and Game, Annual Progress Report, Prepared for U.S. Department of Energy, Bonneville Power Administration, Project No. 87-99, Portland, Oregon.

Maiolie, M. A., B. Ament, and B. Harryman. 1999. Strobe light testing and kokanee population monitoring; Dworshak dam impacts assessment and fisheries investigation. Idaho Department of Fish and Game, Annual Progress Report, Prepared for U.S. Department of Energy, Bonneville Power Administration, Project No. 87BP35167, Portland, Oregon.

Mauser, G., D. Cannamela, and R. Downing. 1989. Dworshak Dam impact assessment and fisheries investigation. Idaho Department of Fish and Game, Annual Progress Report, Prepared for U.S. Department of Energy, Bonneville Power Administration, Project No. 87-99, Portland, Oregon.

Nielsen, L. and D. Johnson. 1985. Fisheries Techniques. American Fisheries Society Bethesda, Maryland.

Scheaffer, R. L., W. Mendenhall, and L. Ott. 1990. Elementary survey sampling, 4th edition. Duxbury Press, Belmont, California.

Rieman, B. E. 1992. Kokanee salmon population dynamics-kokanee salmon monitoring guidelines. Idaho Department of Fish and Game, Job Performance Report, Project No. F-73-R-14, Subproject II, Study II, Boise, Idaho.

Winans, G. A., P. B. Aebersold, and R. S. Waples. 1996. Allozyme variability of *Oncorhynchus nerka* in the Pacific Northwest, with special consideration to populations of Redfish Lake, Idaho. Transactions of the American Fisheries Society 125:645-6663.

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